

METHOD FOR REFINING PAPER FIBERS OR CELLULOSE FIBERS IN AQUEOUS SUSPENSION

Method for treating fiber stock

The invention relates to a method for treating fiber stock according to the preamble of claim 1.

It has long been known that cellulose fibers must be refined so that the paper subsequently produced therefrom possesses the desired properties, in particular strength, formation and surface. The most frequently used refining methods by far use refining surfaces that are provided with bars called knives that are moved past one another at high speed. The corresponding machines are usually called knife refiners. For special cases, refining methods are also used in which at least one of the refining surfaces is knifeless, so that the refining action is transferred by friction forces or shearing forces.

The effect of the method can be controlled within a wide range by changing the refining parameters, whereby in addition to the degree of fineness it is especially distinguished as to whether a greater cutting or greater fibrillating refining is desired. If cellulose fibers are refined, their dewatering resistance usually rises with increasing fineness. A common measure for the dewatering resistance is the freeness according to Schopper-Riegler.

An increase in the freeness value negatively affects the sheet formation in the paper machine, but is tolerated since the above mentioned quality characteristics of the cellulose play a predominant role in its usability. In many cases the refining parameters are selected so that the refining value increase that is required to achieve the desired fiber quality is as low as possible. However, this sphere of influence is very limited. In addition, this may adversely affect the refining process in terms of power economy.

From US 4,685,623 a refining method is known that is designed to manage with less energy. The paper fiber suspension to be refined is guided into wedge-shaped "narrow nips" that form between a revolving center roll and several outer rolls rolling thereon. The wedge-shaped nips are very narrow, since the center roll is provided with a plurality of circumferential grooves or flutes. The outer rolls are pressed with a defined force against the center roll, so that a dewatering and squeezing of the fibers takes place in the wedge-shaped nip. Part of the suspension and the water pressed out in the wedge-shaped nips is thereby guided out crosswise to the direction of movement and in these flutes past the actual wedge-shaped nip in order to be mixed again later with the already refined thickened fiber stock. In this manner problems in the operation of a machine of this type are to be avoided even with larger throughput. In operation the housing of this apparatus is filled up with suspension, which is pumped through with an adjustable volume flow.

In order to hold the fibers in the wedge-shaped nips during the refining, the U.S. document requires the width of the wedge-shaped nip to be smaller than the length of the fibers. However, this means a high expenditure in terms of equipment in the case of a refining machine used industrially.

The object of the invention is to create a method for treating fiber stock with which it is possible to change cellulose fibers or paper fibers such that the strengths of the paper produced therefrom are increased. The increase in the dewatering resistance occurring thereby should if possible be lower than with known refining methods. The method should be suitable for industrial refining machines.

This object is attained through the features cited in claim 1.

The refining method is chiefly effective through compressive forces and avoids large relative movements of the refiner tools. As shall be explained below,

important advantages can be achieved in terms of fiber technology with the aid of a refining method of this type.

In contrast to the conventional knife refiners with high relative speed between the refiner tools, which lead to cutting and/or shearing stress on the fibers, with the refining method considered here the refiner tools are moved little or not at all relative to one another in the refining zone. The actual refining stress therefore occurs through the compressive forces. However in many cases, it has proven problematic to use refining methods of this type on an industrial scale. Namely in the production of paper or paper-like products very large amounts of fiber stock must be constantly supplied for the paper machine. If at least part of the fiber stocks used for paper production (it can also be the entire fiber stock) is to be refined according to the new method, the machines have to be designed for a substantial production quantity. The method according to the invention can help to keep the machine size within limits, since the effectiveness of the fiber treatment can be greatly increased in the refining zone for the reasons given.

The compressive forces in the refining zone can be used to dewater the paper fibers. In the method according to the invention, this means chiefly that the water is either temporarily absorbed by the porous refining surface and later released, or that water can flow off through the porous refining surface into other areas of the refining device. The new method has several advantages:

Firstly, the compressive force is transferred to the fibers with less damping and is therefore used more intensively for their technological change. Moreover, the fibers are fixed onto the refining surface, i.e., they are prevented from leaving the refining zone untreated. This effect occurs essentially irrespective of the fiber length. Moreover, with the same volume, more fibers can reach the refining zone, since the water pressed out is missing. The size of the refining machine used can thereby be reduced accordingly. Moreover, the fiber under considerable pressure lies on a surface provided with many small irregularities, which can have a favorable effect on the refining.

In typical forms of application, the refining surfaces are located on refiner tools that perform a rotational motion, namely such that the liquid absorbed by the pores in the refining zone is spun off again after leaving the refining zone. In particular with open-pore material layers, the pores of which are connected not only to the refining surface, but also to other surfaces, the absorption of liquid and the spinning off of the liquid can be carried out particularly effectively.

Particularly suitable materials for producing a porous refining surface for carrying out the method are hard metals, chromium steel, plastics (e.g., polyethylene, GRP), ceramics or copper alloys. These materials can be sintered. As is known, however, open-pore workpieces suitable for the use considered here can also be produced in a targeted manner from composite materials. The pore size can be individually adjusted according to the requirements between 5 μm and 0.5 mm.

The advantages of the method in terms of refining technology are as follows:

1. The fiber length is maintained much better.
2. The fiber surface is not fibrillated or is fibrillated much less.
3. The specific refining work to achieve the desired strengths is generally lower.

Comparative tests with long-fiber cellulose have shown that to achieve a breaking length of 8 km with a knife refining a 45° SR freeness degree resulted and with the new method only 18°SR. The required specific refining work was up to 50% lower.

It can be assumed that through the new refining method the surface of the fibers is changed such that they receive an improved flexibility and bonding capability, without having to detach fibrils from the outer surface of the fibers. The production of fines, i.e., fiber fragments, is also avoided.

If the method is used for recycled fibers, the cited advantages can be particularly important. Recycled fibers have already undergone at least one and often even

several refining processes, so that avoiding any further size reduction is welcome.

The invention and its advantages are explained on the basis of drawings. These show:

Fig. 1 Detail view of a refining zone with bar-shaped refining surfaces to explain the method;

Fig. 2 A variant with cylindrical refining surfaces;

Fig. 3 Part of a special refining device;

Fig. 4 A refining device with central refiner cylinder and refiner rolls arranged on the periphery;

Fig. 5 A refining device in which the porous layer of the refiner cylinder is provided with chambers on the back.

A particularly suitable device for carrying out the method can have a rotating refiner cylinder 3, on which a number of refining rolls 4 are pressed from the outside. The refining surfaces 1 or 2 are located on them. The pressing force thereby influences the refining effect and can therefore preferably be adjusted.

Fig. 1 shows part of a refining device of this type, in particular the site at which a refining zone is produced through the interaction of refiner cylinder 3 and refiner roll 4. In the example shown, both refiner cylinder and refiner roll are provided with refiner bars 5 or 6, only part of which is drawn. They extend essentially at right angles to the direction of movement of the refiner tools and are distributed evenly over the circumference. The refiner bars are thereby dimensioned and arranged such that in the refining zone the refiner bar 5 of one refiner tool extends into the gaps between the refiner bars 6 of the other refiner tool, whereby the volume lying between them is reduced and a considerable pressure is built up in the suspension S (indicated by an arrow) located therein. Both the refiner bars and the cylindrical outer layer of the corresponding refiner tool connected thereto are here made of porous material. It may be sufficient to

produce only the refiner bars from porous material and to attach them to the refiner cylinder or to the refiner roll.

As has already been described, the water of the fibrous suspension under increased pressure in the refining zone can penetrate into the pores of the refining surface, whereby the fiber stock itself is thickened. After passing through the refining zone, the volume lying between the refiner tools is increased again and the water W (indicated by an arrow) can exit from the pores again. This effect is greatly supported by the fact that both refining surfaces rotate, so that a centrifugal force acting perpendicular to the refining surface is generated. Since the refiner bars form a toothing, within the refining zone the relative speed of the two refiner tools to one another is low, whereby shearing movements and shearing forces acting on the fibers are largely avoided. Moreover, the toothing also has an impact in terms of refining technology, which lies in the fact that the compressive forces acting on the fibers occur in a pulsing manner, which is desired in terms of refining technology in many cases. Fig. 2 shows another application with cylindrical refining surfaces, i.e., those that are not provided with bars and that roll against one another slip-free or with low slip to carry out the method. In this representation it is discernible that the refiner cylinder 1' is provided with a porous layer 8' and the refiner rolls 4' are provided with a porous material layer 7'. In another embodiment, not shown, it can also be sufficient for only one of the two refiner tools that together form a refining zone to have a porous refining surface. This applies to cylindrical refining surfaces (cf. Fig. 2) and to bar-shaped refining surfaces (cf. Fig. 1).

The advantages provided by the method according to the invention are highlighted in particular when the refining device in operation is not completely filled with suspension. This principle is shown by way of example in Fig. 3. In turn, a refiner cylinder 3 is discerned against which several refiner rolls 4 interlocking therewith are pressed, two of which are drawn here. The refining surfaces are porous. Since the housing of the refining device is filled with

suspension only to a small extent, after leaving the refining zone the suspension S is spun out of the gaps 20 between the teeth into the free space through centrifugal forces and reaches the next refiner roll. In the free space the liquid has a much higher density than the air surrounding it. The water that when passing through the refining zone was pressed into the pores due to the porosity of the refining surfaces, can now likewise be spun out and reach the next refining zone. Moreover, Fig. 3 shows that the refiner bars can have the form of an involute toothing, which optimizes the rolling conditions in the refining zone, but is somewhat more complex to produce than, e.g., the refiner bars shown in Fig. 1. The refiner rolls 4 here rotate in a fixed link 11. The refiner cylinder 3 has shoulders 12 running in an annular manner on the axial front sides, which shoulders seal the volume formed between the refiner bars 5, 6 in the refining zone in an axial manner.

The refining device shown in Fig. 4 for carrying out the method is depicted only diagrammatically. A refiner cylinder 3 lying horizontally is discernible, on which cylinder several refiner rolls 4 chiefly arranged uniformly distributed over the circumference are located, whereby a gap 9 is left without refiner roll in the area of the stock outflow 13. The suspension S is added through an inflow 14. This can take place via a broad nip or via a headbox, similar to that known from paper machines. The addition point lies next to the stock outflow 13 and is separated therefrom by a guide plate 15. A forced conveying over almost 360° over the entire circumferential course of the housing 16 is thus ensured. The suspension flow through this refining device is defined and can be adjusted easily and reliably. The housing is preferably not completely filled with suspension for the reasons already given. However, a suspension level can form at the stock outflow 13. The housing 10 can be cylindrical in the interior, as drawn here, or can be provided with a link 11 according to Fig. 3, in which the refiner rolls rotate with small nip spacing.

It is easily possible to produce porous layers in which the capillary cavities are connected to one another. The dewatering effect can be substantially improved if the water pressed into the pores is removed again after leaving the refining zone. To this end, e.g., centrifugal forces can be used. The water is not then constantly pressed in one direction through the pores as, e.g., with filter elements. Instead, the pores serve as storage capacity with a return of flow that immediately rinses away again the adhering fines or possibly fines that have penetrated.

It is easy to appreciate that the dewatering effect of the porous refining surface can act effectively particularly when it is possible to keep the pores free from clogs. In order to avoid any difficulties in this regard, it can be expedient to provide a chamber on the back of the porous layer (i.e., the side of the layer lying opposite the refining surface). If necessary, this can be fed with pressurized water. The water is possibly mixed with suitable cleaning chemicals. A simple possibility for realizing a chamber 17 of this type is shown by Fig. 5 by the example of a refiner cylinder 3" that is surrounded by refiner rolls 4' in a peripheral manner. In this example, the chambers 17 are formed in that spacer bars 18 are installed between the material layer 8' porous throughout and the cylinder body of the refiner cylinder 3", between which bars the volumes of the chambers 17 remain free. The rinsing water is added through lines 19.

In another embodiment of the method, the chambers 17 shown in Fig. 5 and the lines 19 connected thereto can be used to drain off water that has penetrated through the pores of the material layer 8'. A time sequence of dewatering and, if necessary, rinsing, is also conceivable.

Of course, this embodiment with chambers 17 shown here on cylindrical refining surfaces can also be used with other refining surface shapes.